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March 9, 1995

Mr. William F. Caton, Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

In re: PR Docket No. 92-235
Ericsson Inc.
Ex Parte Communication

Dear Mr. Caton:

Pursuant to the provisions of Section 1.1206 of the Commission's rules, please be advised that on March 8, 1995, representatives of Ericsson Inc. met with the Wireless Telecommunications Bureau to discuss issues related to the above-referenced proceeding.

The attached document was submitted during the course of the meeting. An original and one copy of the document is being submitted herewith for inclusion in the record of this proceeding.

Should there be any questions with regard to this matter, kindly communicate directly with the undersigned.

Very truly yours,

David C. Jatlow
Counsel for Ericsson Inc.

cc: Kathryn Hosford (w/encl)

MASK "FLAT TOP" REGION

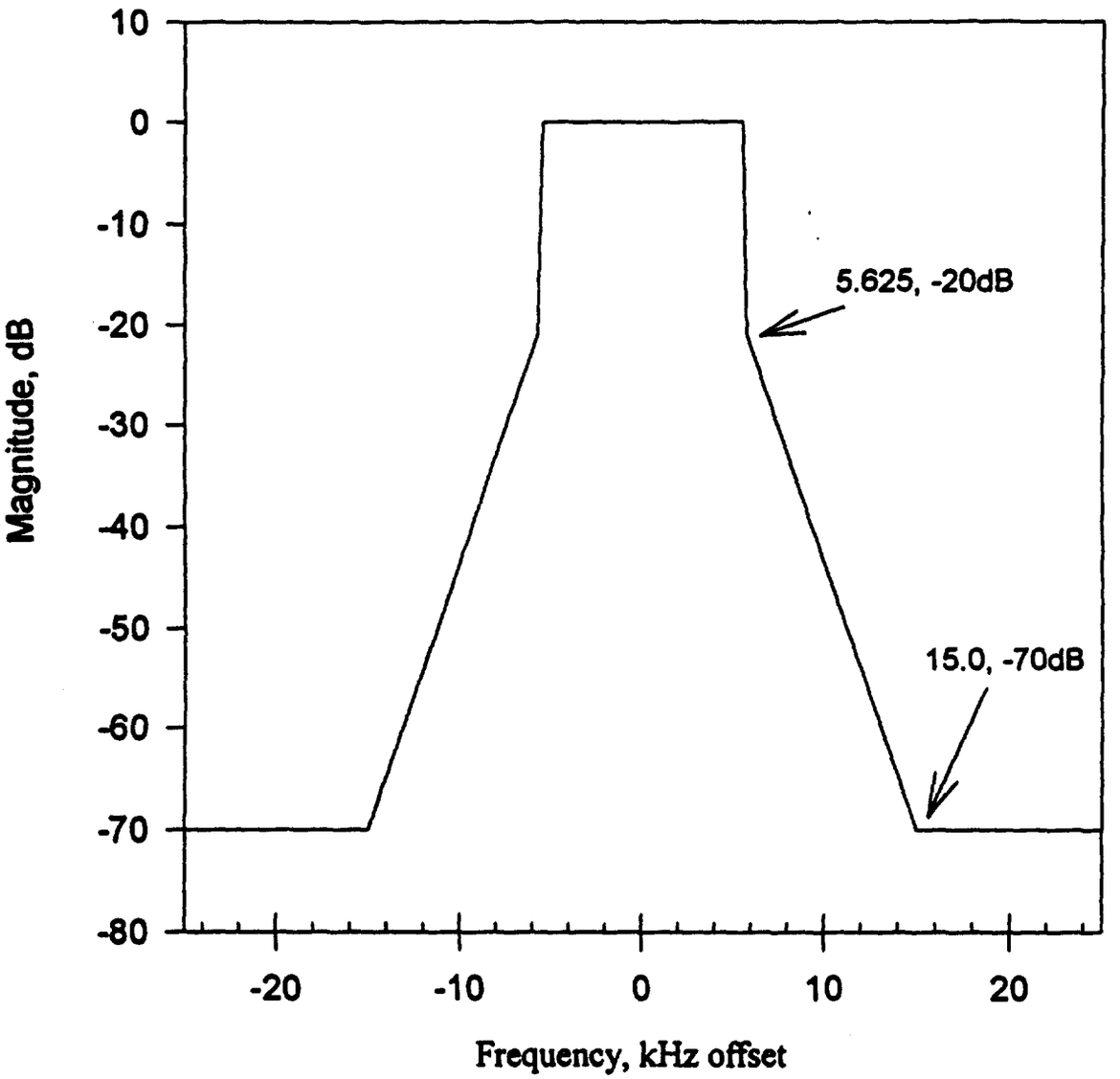
- Advanced Digital Modulations
  - More Rectangular than Triangular Main Lobe
- Applicable for Traditional or Analog Modulations

Ericsson Recommends Rectangular, Flat Top Region Around Mask Center

Fig. 1

Original Ericsson Recommended Mask

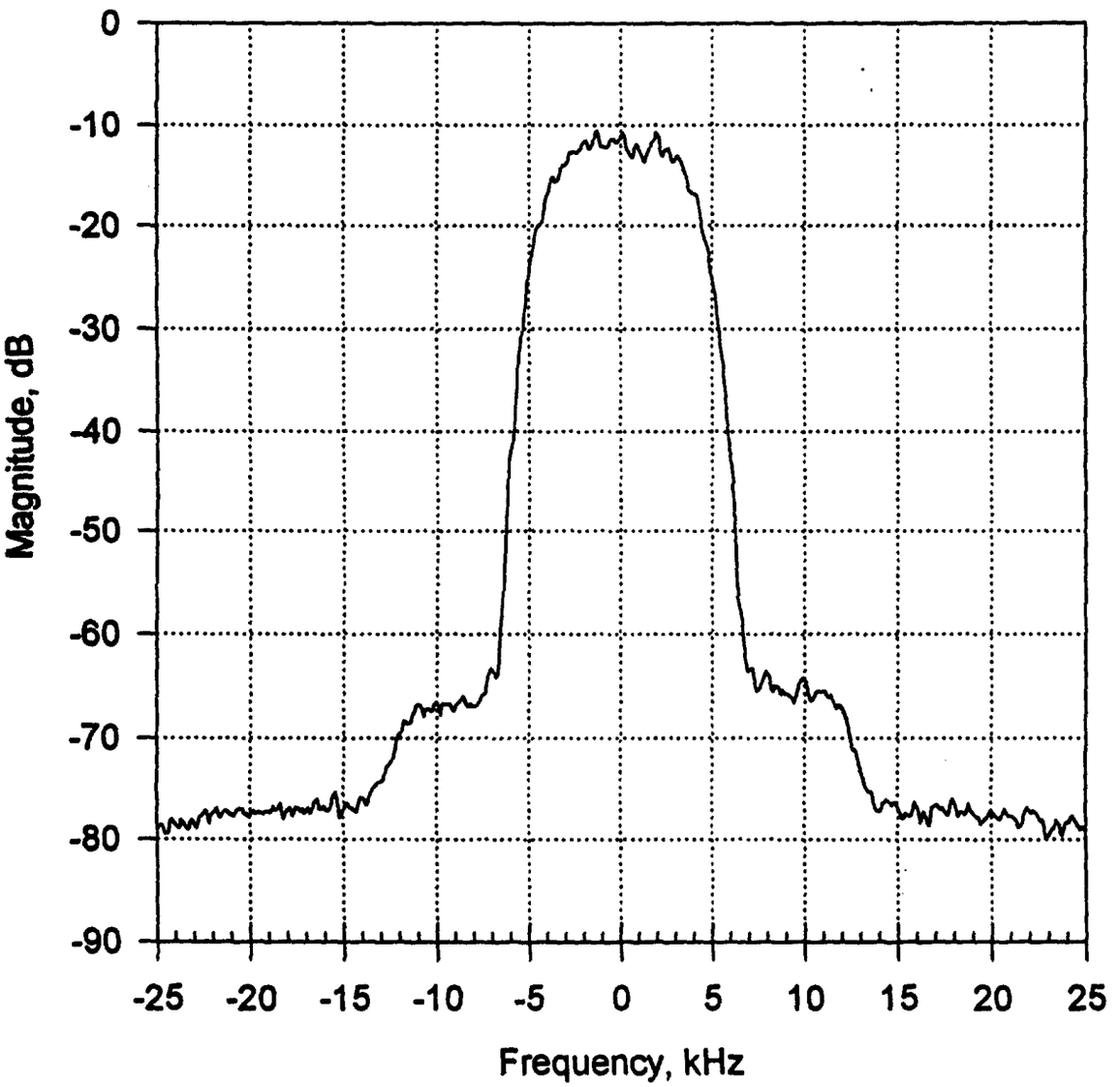
12.5 kHz Channels



Displacement Frequency (f_d)	Attenuation (dB)
0 kHz to 5.625 kHz	0
5.625 kHz < f_d < 15 kHz	5.3(f_d-1.8 kHz)
15 kHz < f_d	50 + 10log$_{10}$(RFOP), or 70 whichever is smaller

Fig. 2

Typical QPSK Modulation Spectrum



MASK "SKIRT" REGION

- Originally Recommended Mask and Comparison

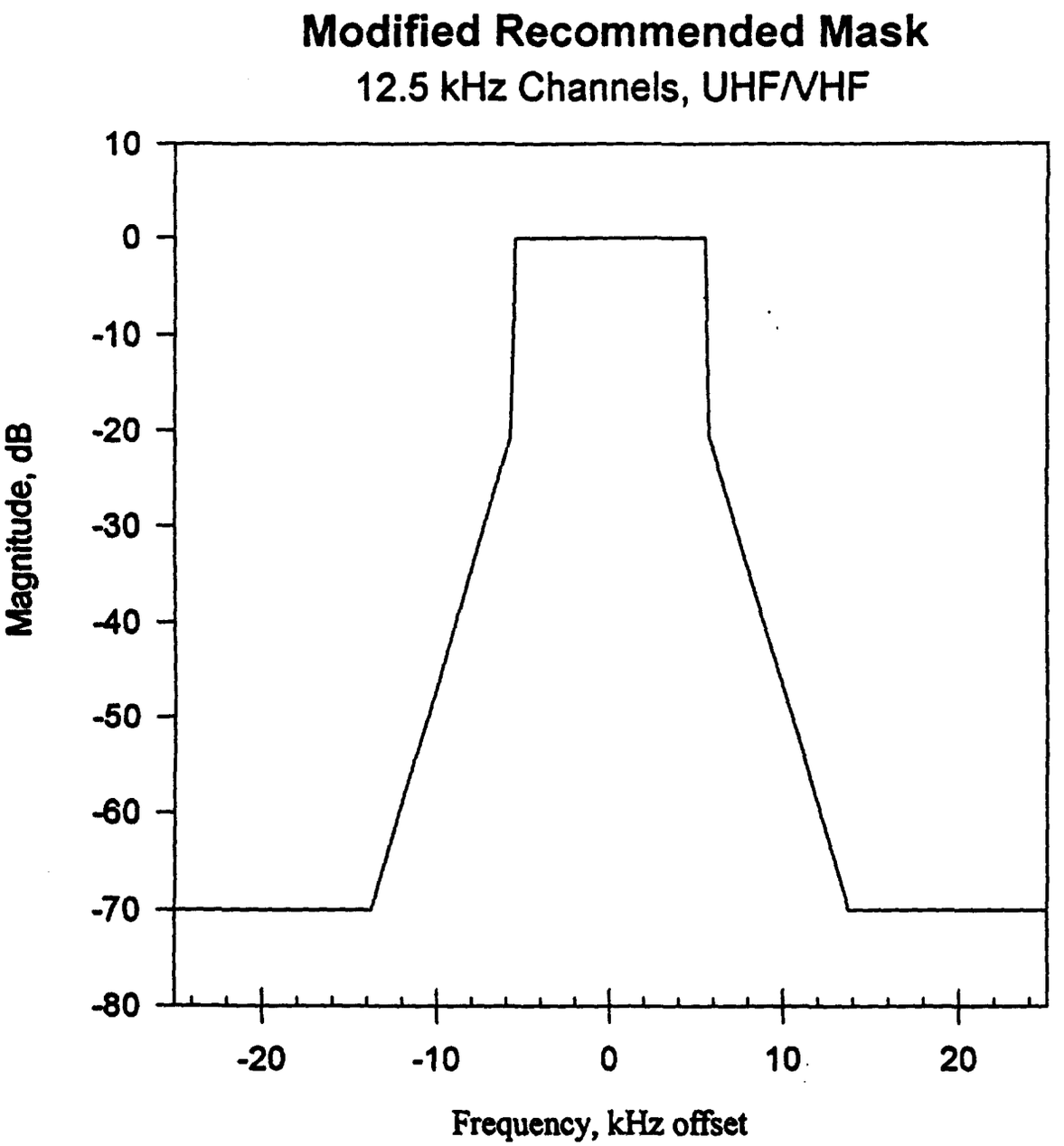
- Modified Recommended Mask
  - Simulations and Measurements
  - Steeper Attenuation Characteristic

    70 dB intersection at 13.75 kHz
    Midway between 12.5 (TIA) and 15.0 (Original Ericsson)

- Adjacent Channel Performance
  - Experimental Configuration
  - Qualitative Comparison

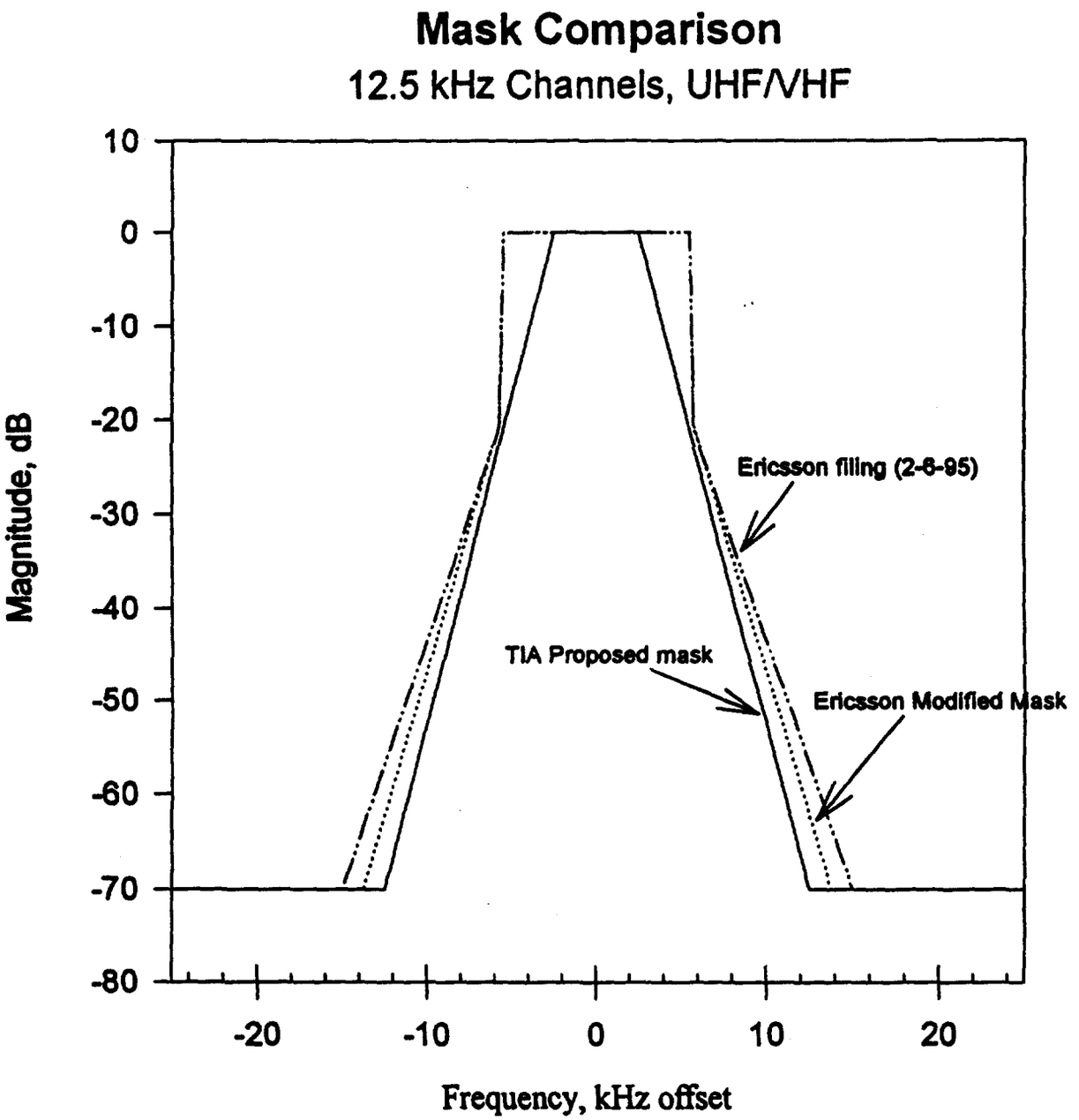
Ericsson Recommends Modified Mask With Steeper Attenuation Characteristic in Skirt Region

Fig. 3

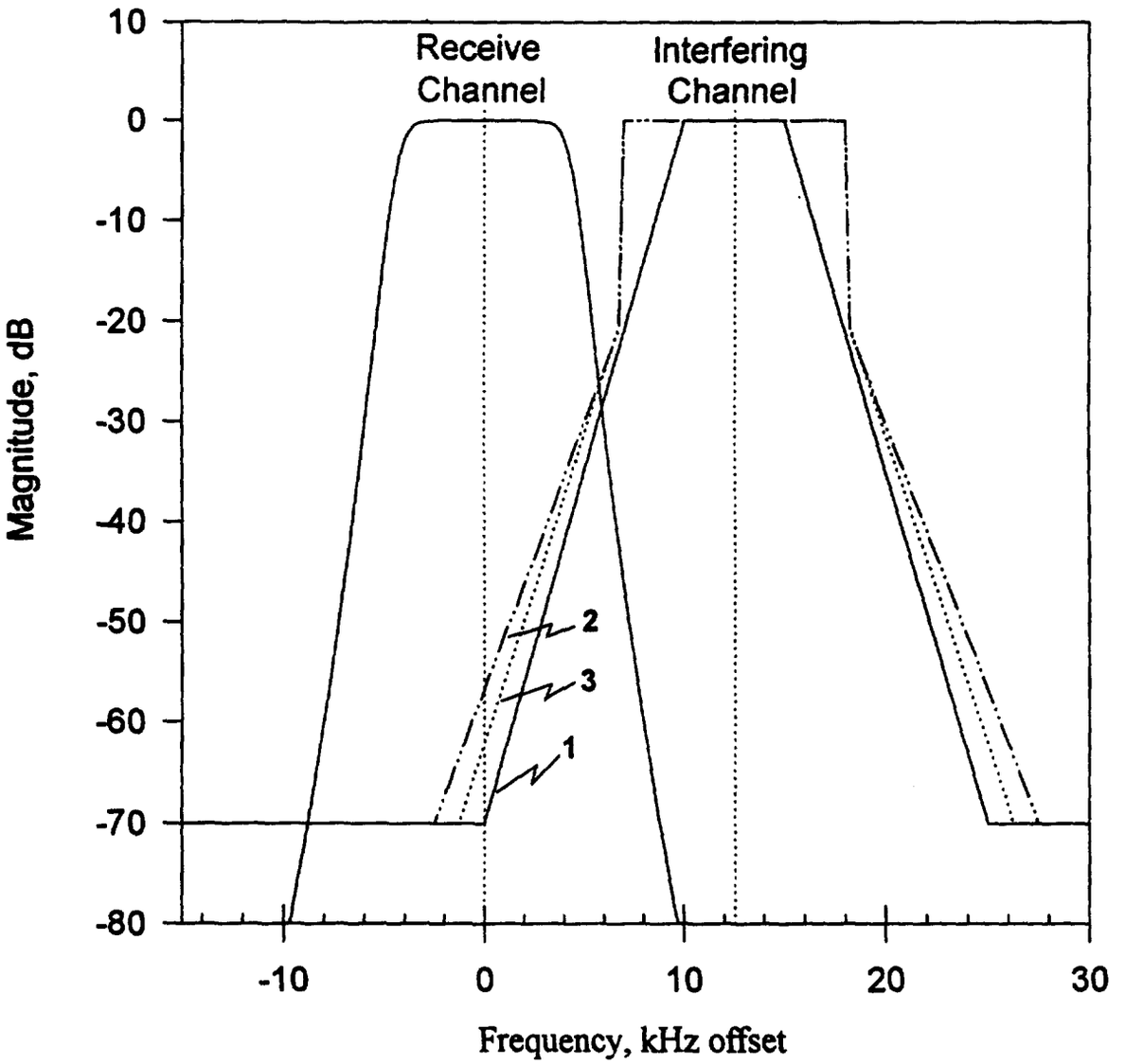


Displacement Frequency (f_d)	Attenuation (dB)
0 kHz to 5.625 kHz	0
5.625 kHz < f_d < 13.75 kHz	6.15(f_d-2.4 kHz)
13.75 kHz < f_d	50 + 10log$_{10}$(RFOP), or 70 whichever is smaller

Fig. 4


Mask Comparison
12.5 kHz Channels, UHF/VHF
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Magnitude, dB
-20
-10
0
10
20
Frequency, kHz offset
Ericsson filing (2-6-95)
TIA Proposed mask
Ericsson Modified Mask

Adjacent Channel Interference Measurement



Receiver

Ericsson Portable MPA

Interfering Signals

1 TIA Mask Skirt

2 Original Ericsson Mask Skirt

3 Modified Ericsson Mask Skirt

EMISSION SPECTRUM MEASUREMENT

- Resolution Bandwidth
  - 100 Hz or Less Versus 300 Hz
- Average Spectral Amplitude Detection
  - Average Versus Peak or Maximum Hold Detection
  - Peak or Max Hold Cause Erroneous Results for TDMA Waveforms
  - Average Accurate for TDMA

Ericsson Recommends

- **100 Hz or Less Resolution Bandwidth**

  and

- **Average Detection Methods - Applicable to TDMA Waveforms**

SUMMARY AND DISCUSSION

- Mask "Flat Top" Region Recommendation
- Mask "Skirt" Region Recommendation
- Emission Spectrum Measurement
  - Resolution Bandwidth
  - Detection Measurement Method

ADDENDUM--ERICSSON RECOMMENDED EMISSION MASKS

Introduction

This document is an addendum to the Ericsson document[1] that was presented to and reviewed with representatives of the Federal Communications Commission (FCC) on February 6, 1995. This addendum addresses several comments and questions that have been made by the representatives of the FCC.

Ericsson supports the goals of refarming the frequency bands below 512 MHz and especially the goal "to encourage technical flexibility and spectrum efficiency."[2] The development and implementation of new advanced modulation and emission technologies in the land mobile radio industry is moving at a rapid pace. Advanced modulations to achieve increased spectrum efficiency include a family of linear modulations such as DQPSK, LM, O QPSK and QAM as well as a family of non-linear modulations such as CPM, GMSK, GFSK, and C4FM. Also, new access methods such as Time Division Multiple Access (TDMA) are being developed to increase spectrum efficiency and provide technical flexibility. In the period since comments were filed in 1993, Ericsson has performed extensive research and product development for new generations of equipment that will be affected by the proposed mask changes. Ericsson believes that the masks accepted by the Commission should accommodate a wide range of current and envisioned modulation and emission technologies. The masks proposed in Reference 1 and in this addendum are not technology limiting and will enable numerous analog and digital modulation schemes to be deployed and still meet the Commission's goals. Adoption of the type of masks proposed will encourage technical flexibility and innovation and will result in a wider variety of products deployed. Another result will be greater competition in the equipment marketplace which will ultimately provide lower cost to the end users.

Ericsson now believes that the Commission will adopt rules that will require refarming to occur in one or two steps. Based on this assumption, Ericsson has provided a recommendation in its February 6, 1995 filing (Reference 1) for a mask for 12.5 kHz channels that could be used to provide either 12.5 kHz channel efficiency or 6.25 kHz equivalent channel efficiency. The former would result with one user per 12.5 kHz channel and the latter with two users (two user TDMA configuration) per 12.5 kHz channel. For reference, the 12.5 kHz mask Ericsson originally recommended is shown in Figure 1.

In this document, amplification is provided for the recommendation of selected features of the mask including the "flat top" region and the "skirt" region. After questions by the

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[1] "Ericsson Recommended Emission Masks", Written Ex Parte Communication, The Ericsson Corporation, February 6, 1995.

[2] Report and Plan of the Federal Communications Commission, Meeting State and Local Government Public Safety Agency Spectrum Needs Through the Year 2010, February 9, 1995.

FCC representatives and further review and measurement, a revision to the "skirt" region of the originally recommended mask is proposed. Further, a revision to the current emission spectrum measurement and validation parameters is strongly recommended to achieve much more accurate measurement of the actual emission spectrum.

Mask "Flat Top" Region

The advanced digital modulations such as QPSK have power spectrums with a main lobe that is more rectangular than triangular in the peak or top region. These spectrums provide more uniform, high level energy across the channel width which results in more spectrally efficient communication system operation. Figure 2 shows a power spectrum for a typical QPSK modulation and illustrates the more rectangular main lobe shape. To accommodate these advanced modulations which provide technical flexibility and spectrum efficiency, Ericsson recommends the rectangular, flat top region around the center of the mask as illustrated in Figure 1. This flat top feature permits inclusion of many modulation types and will not preclude the use of traditional or analog modulations. The width of the flat top has been determined by considering many modulation scemes and adjacent channel interference protection.

Mask "Skirt" Region

The originally recommended mask contains a "skirt" region with a linearly increasing attenuation with frequency referenced to the carrier from 20.3 dB at 5.625 kHz to 70 dB at 15.0 kHz. This attenuation shape characteristic in this frequency region is very close to the proposed Part 88.421(g) (2) 896-901 MHz/935-940 MHz (same as Part 90.209(h)) for 12.5 kHz channels and to the NTIA Narrowband Mask[3] for 12.5 kHz channels. In fact, the NTIA mask requires a maximum attenuation of 60 dB versus 70 dB for the other masks. Considering these other approved masks for narrowband 12.5 kHz channels, Ericsson believes that its originally proposed mask with essentially identical attenuation in the "skirt" region was reasonable and consistent with other frequency bands.

However, Ericsson recognizes that the proposed TIA/Motorola mask has a steeper attenuation characteristic in the "skirt" region and intersects the 70 dB attenuation level at 12.5 kHz rather than the 15.0 kHz in the Ericsson proposal. Ericsson also recognizes the concern expressed by the FCC that the originally recommended Ericsson mask could allow a slightly higher interference level in the adjacent channel than the TIA/Motorola mask. In response to the FCC concern, Ericsson has performed a series of simulations and experimental measurements for a variety of current and future advanced modulations

[3] "Channeling Plan for Assignments in the Band 162-174 MHz", Section 4.3.7, National Telecommunications and Information Administration (NTIA) Manual, Revised 9/92.

that could be employed. As a result of these simulations and experiments, Ericsson has determined that the attenuation characteristic in the skirt region could be made steeper such that the intersection with the 70 dB level is midway between the 12.5 and 15.0 kHz points or at 13.75 kHz. This change tightens the mask and will further reduce the adjacent channel interference. This modified Ericsson recommended mask is defined and illustrated in Figure 3. A comparison of the relevant masks is shown in Figure 4. Laboratory measurements have been made on an Ericsson narrowband digital receiver designed for 12.5 kHz channel operation to characterize the difference in adjacent channel interference performance for adjacent channel interferers that have a spectral shape in the skirt region corresponding to: (1) the originally recommended Ericsson mask, (2) the modified Ericsson recommended mask, and (3) the TIA proposed mask. The mask comparison in Figure 4 illustrates the differences of these masks in the skirt region. The originally recommended Ericsson mask and the TIA mask showed about a 6-7 dB difference in adjacent channel performance. However, the modified Ericsson recommended mask and the TIA mask showed less than 3 dB difference in adjacent channel performance and little noticeable difference in voice quality even at low signal levels that would occur in the coverage fringe area. Ericsson believes that the modified Ericsson recommended mask is responsive to the FCC concern and will ensure adequate adjacent channel interference protection.

Emission Spectrum Measurement

A key and closely allied item of high importance when specifying emission masks for narrowband channels is specifying an accurate and appropriate method of measurement of the emission spectrum. The advanced access techniques such as TDMA and advanced, spectrally efficient modulation technologies such as QPSK are radically different in nature from traditional FM-and FSK-based systems. Therefore, applying measurement methods developed for FM systems can give misleading or erroneous results when used with the newer, spectrally efficient technologies. Ericsson has conducted significant research and product development on next generation TDMA digital systems with advanced modulations. Instead of exclusively following TIA 603 methods of measurement, which were developed for traditional non-TDMA equipment, Ericsson strongly recommends adding (re-instating) the following two articles in the Part 88 rulings which will allow much more accurate measurement of the actual emission spectrum for both Frequency Division Multiple Access (FDMA) and TDMA access methods:

1. For narrowband channels (12.5 kHz and narrower), use 100 Hz or less resolution bandwidth for measuring spectral emissions (rather than 300 Hz). This resolution bandwidth will provide improved accuracy in resolving spectral components and will provide a much more accurate measurement of the actual emission power spectral density. The 300 Hz bandwidth value originally represented a limitation of test equipment. However, today, 100 Hz resolution bandwidth is quite standard and spectrum

analyzers with 10 Hz to 1 Hz resolution bandwidth or less are available. The specification of 100 Hz resolution bandwidth was included in the original Part 88 NPRM and Ericsson recommends that it be included as part of the FCC's final rule. Further, it is Ericsson's understanding that the 100 Hz resolution bandwidth is included in the current Part 88 draft for 6.25 kHz channelization.

2. Average spectral amplitude detection (rather than only peak detection and/or maximum hold settings) should be allowed, especially for digital and TDMA transmissions. With TDMA transmissions, the transmitted waveform exhibits an on/off duty cycle of 50 percent or less. Further, during the part of the cycle that the waveform is being transmitted, the envelope of the transmission is not constant for the advanced digital linear modulations. Traditional swept spectrum analyzers are notoriously inaccurate and unpredictable when used to view TDMA signals or signals with non-constant power envelopes. Improvements in test equipment technology and products (such as FFT-based analyzers) have made it possible to accurately measure the spectra of TDMA and other modern modulation techniques. The allowance for use of modern, advanced test equipment is clearly in the public interest. Therefore, to maintain applicability to modern systems, Ericsson strongly recommends adopting average detection as an option for measuring spectral emissions.

Figure 5 illustrates the variations in spectral measurement for different sweep modes and resolution bandwidths for a typical QPSK modulation. Figure 6 shows the variations in spectral measurement with similar measurement parameters for a 4:1 TDMA (25 percent duty cycle) with a typical QPSK modulation. Clearly Figures 6a, 6b, 6d, and 6e show that conventional spectrum analyzer techniques yield completely inaccurate measurements of the actual spectral density. These figures illustrate that the measurement methods and settings recommended here provide much more accuracy in estimating the actual spectral density. Further, Figure 6 demonstrates the inapplicability of improper measurement techniques to TDMA technology.

Summary

Ericsson supports the goals of refarming the frequency bands below 512 MHz and especially the goal to encourage technical flexibility and spectrum efficiency. Further, Ericsson believes that the emission masks accepted by the Commission should accommodate a wide range of current and envisioned modulation and emission technologies. It is from this perspective that the original Ericsson mask recommendation was made and it is also from this perspective that the recommended modifications described in this document are made.

Based on questions by the FCC representatives and further review and measurement, Ericsson proposes several modifications in the following areas: mask "flat top" region, mask "skirt" region, and emission spectrum measurement.

Mask "Flat Top" Region - Ericsson recommends a rectangular, flat top region around the center of the mask as illustrated in Figures 1 and 3 to accommodate advanced digital modulations which will provide technical flexibility and spectrum efficiency.

Mask "Skirt" Region - A revision to the skirt region of the originally recommended Ericsson mask is proposed. The attenuation characteristic in this region is steeper such that the intersection with the 70 dB level is midway between the 12.5 (TIA mask) and 15.0 kHz (original Ericsson recommendation) points or at 13.75 kHz. This change tightens the mask and will further reduce the adjacent channel interference. This modified Ericsson recommended mask is defined and illustrated in Figure 3 with a comparison of the relevant masks shown in Figure 4.

Emission Spectrum Measurement - A key and closely allied item of high importance when specifying emission masks for narrowband channels is specifying an accurate and appropriate method of measurement. Instead of exclusively following the TIA methods of measurement, which were developed for non-TDMA and constant envelope FM/FSK equipment, Ericsson strongly recommends adding the following two articles in the Part 88 rulings which will allow much more accurate measurement of the actual emission spectrum for both FDMA and TDMA access methods:

1. For narrowband channel (12.5 kHz and narrower), use 100 Hz or less resolution bandwidth for measuring spectral emissions (rather than 300 Hz). These finer resolution bandwidths will provide more measurement accuracy and are standard on modern commercial test equipment.

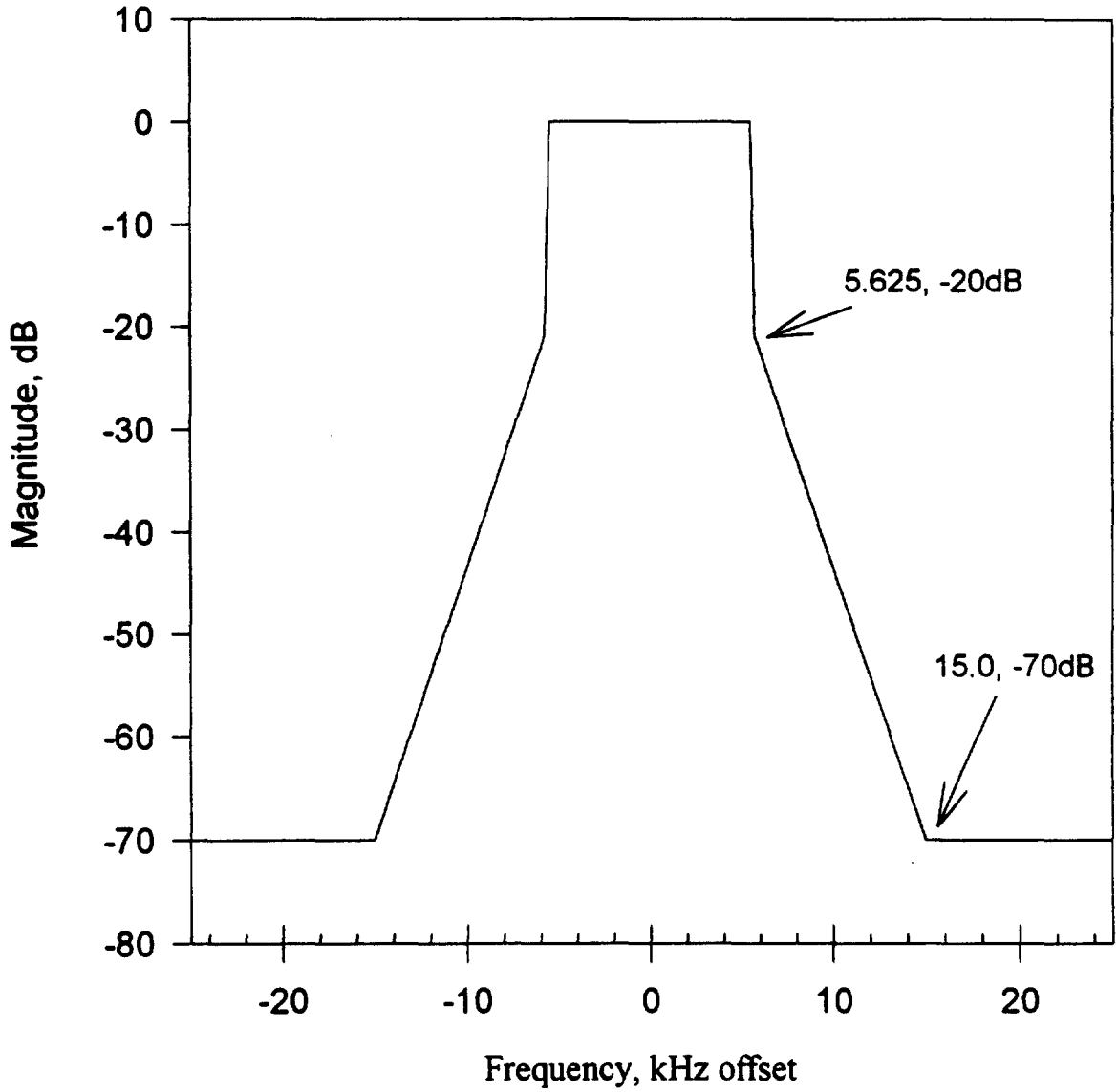
2. Average spectral amplitude detection (rather than only peak detection and/or maximum hold settings) should be allowed as an option especially for digital and TDMA transmissions. Traditional swept frequency analyzers can provide erroneous results for TDMA-like transmissions as illustrated in Figure 6. Improvements in test equipment technology and commercial products (such as FFT-based analyzers) have made it possible to accurately measure the spectra of TDMA and other modern modulation techniques.

It is hoped that the amplification and modifications described in this document are fully responsive to the FCC comments and questions.

Fig. 1

Original Ericsson Recommended Mask

12.5 kHz Channels



Displacement Frequency (f_d)	Attenuation (dB)
0 kHz to 5.625 kHz	0
5.625 kHz < f_d < 15 kHz	5.3(f_d-1.8 kHz)
15 kHz < f_d	50 + 10log$_{10}$(RFOP), or 70 whichever is smaller

Fig. 2

Typical QPSK Modulation Spectrum

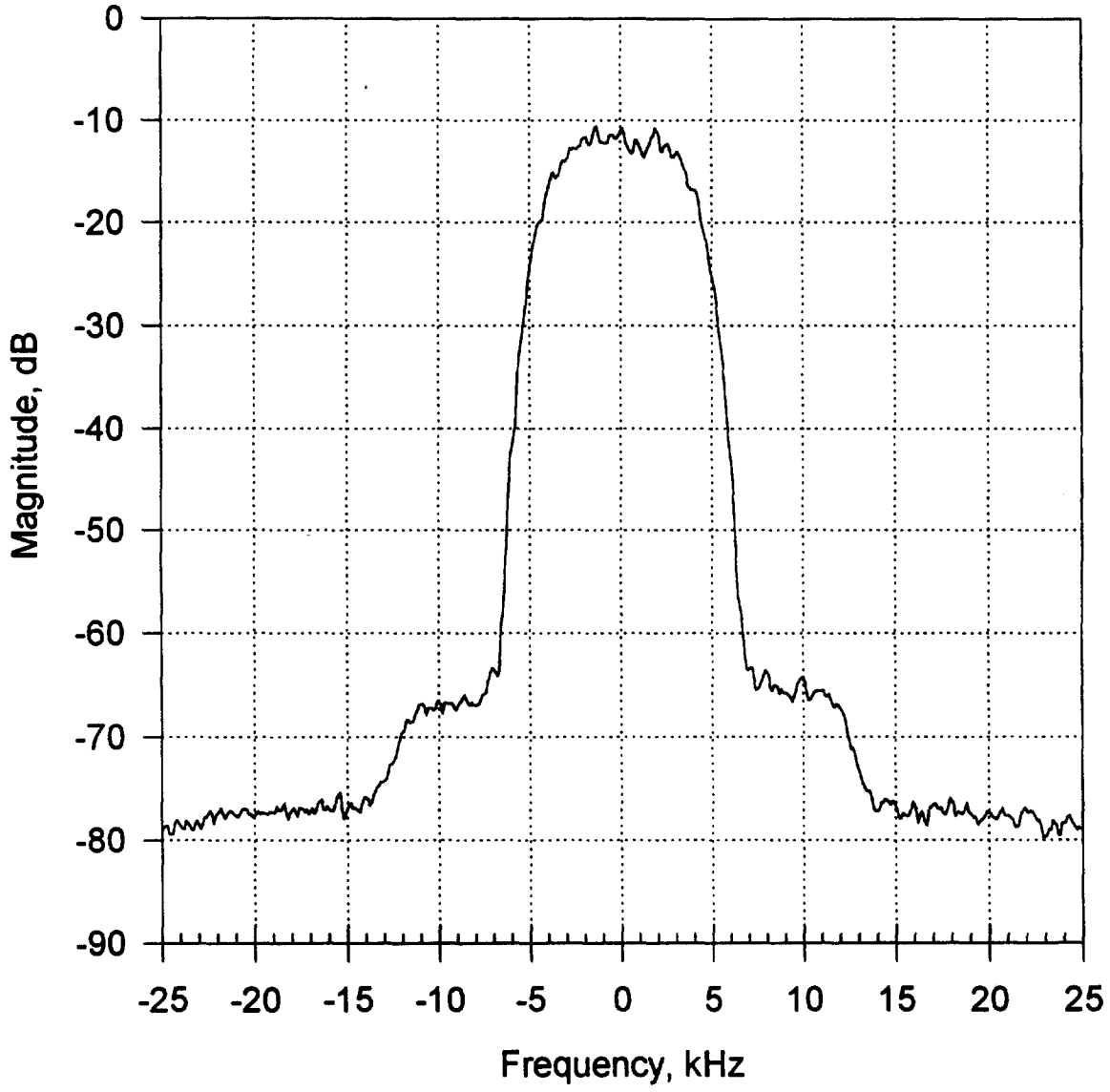
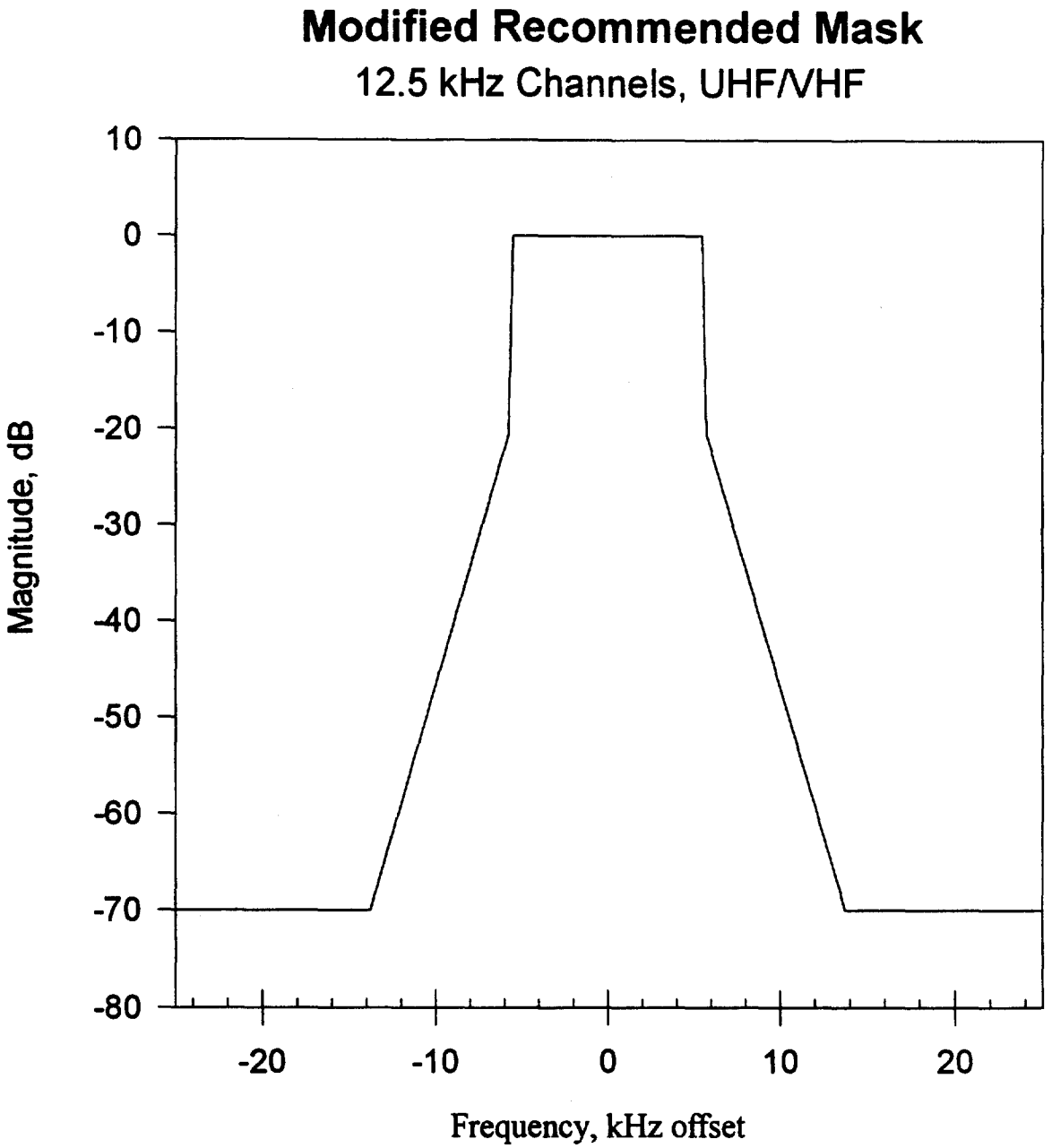


Fig. 3



Displacement Frequency (f_d)	Attenuation (dB)
0 kHz to 5.625 kHz	0
5.625 kHz < f_d < 13.75 kHz	$6.15(f_d - 2.4\ kHz)$
13.75 kHz < f_d	$50 + 10\log_{10}(RFOP)$, or 70 whichever is smaller

Fig. 4

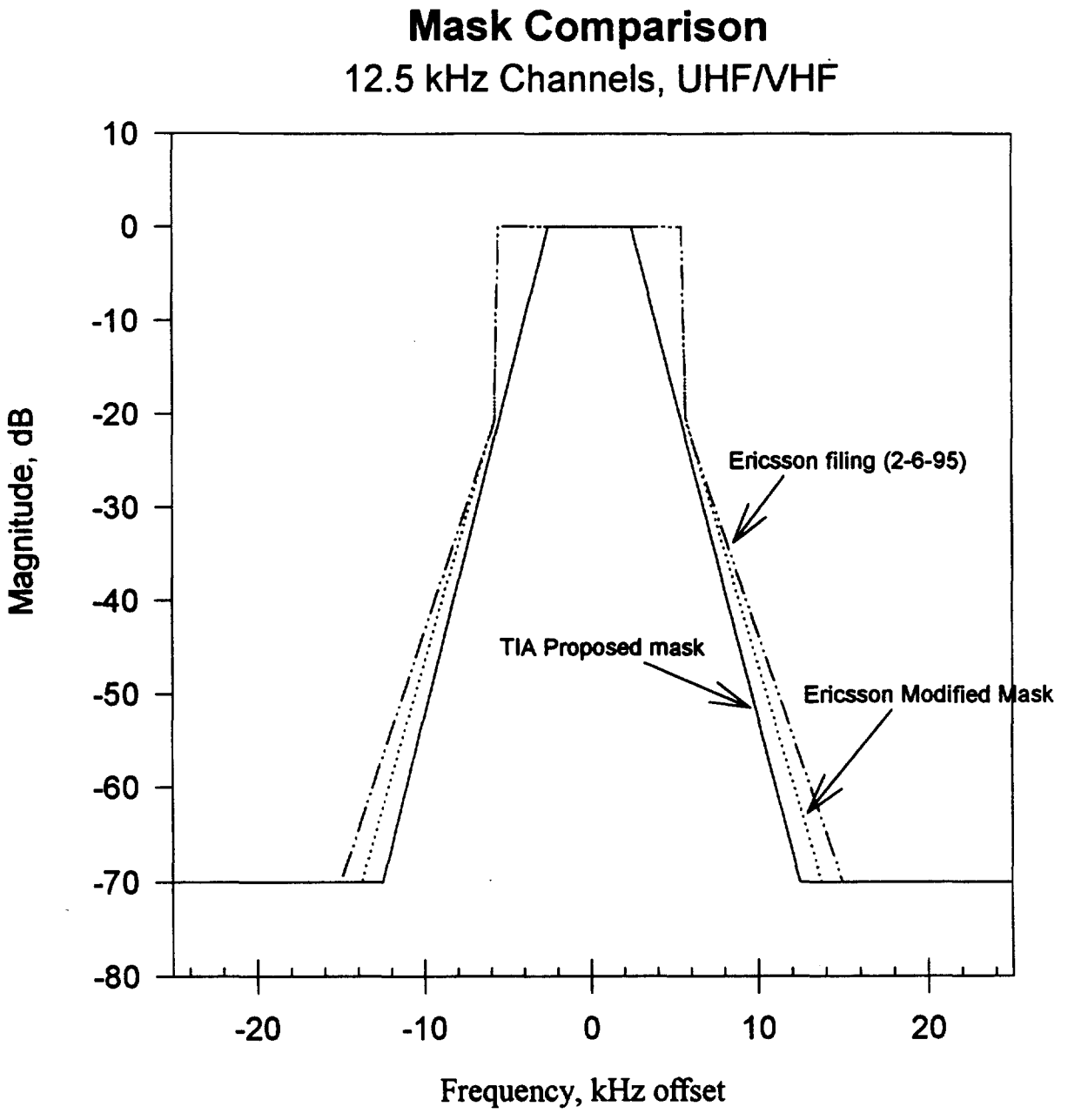
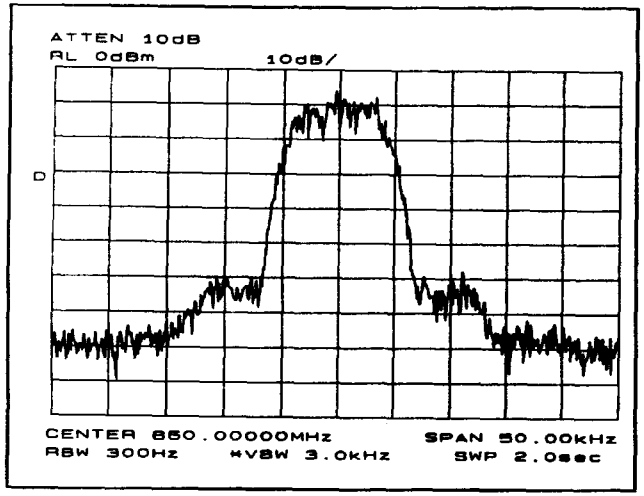
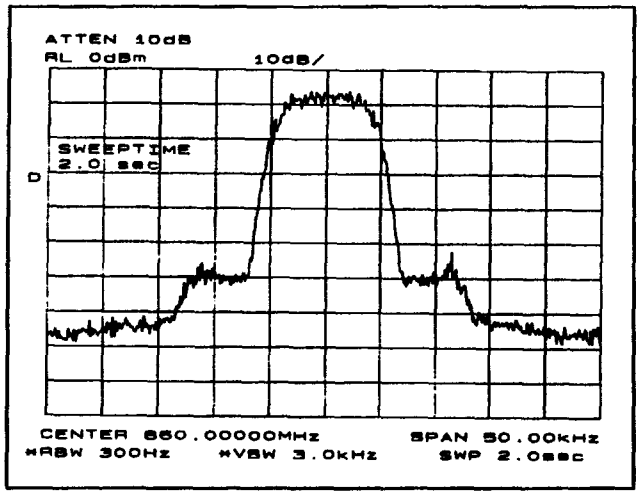

Mask Comparison
12.5 kHz Channels, UHF/VHF
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Magnitude, dB
-20
-10
0
10
20
Frequency, kHz offset
Ericsson filing (2-6-95)
TIA Proposed mask
Ericsson Modified Mask

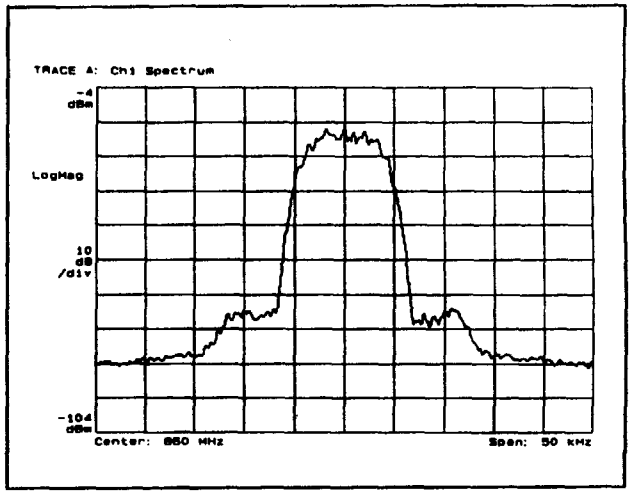
Figure 5 - Effects of Measurement Methods on Non-TDMA QPSK Modulation



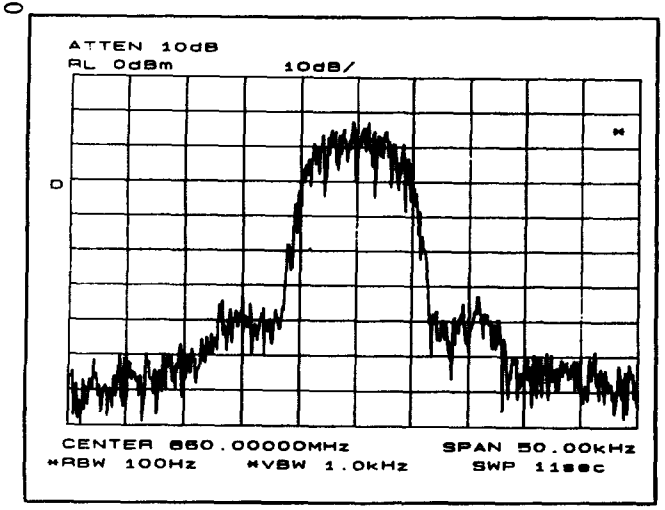
a) Single Sweep, Peak Detection,
300 Hz Resolution Bandwidth



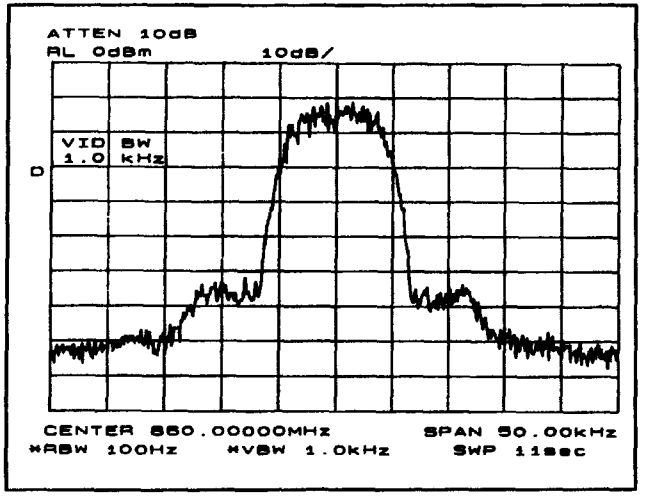
b) 10 Sweep Max Hold, Peak Detection,
300 Hz Resolution Bandwidth



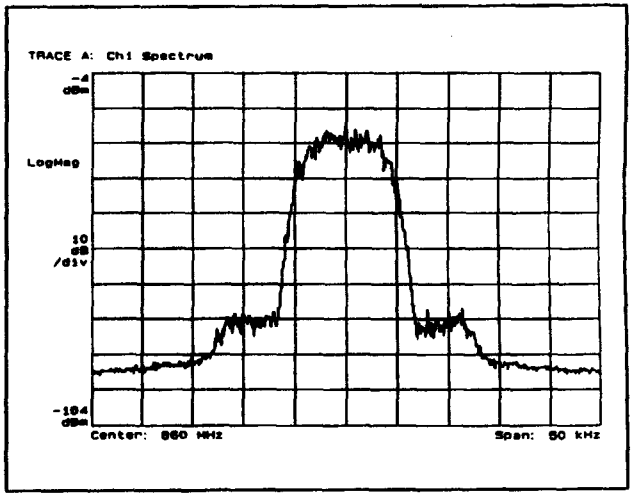
c) True RMS Average Detection,
300 Hz Resolution Bandwidth



d) Single, Sweep, Peak Detection,
100 Hz Resolution Bandwidth

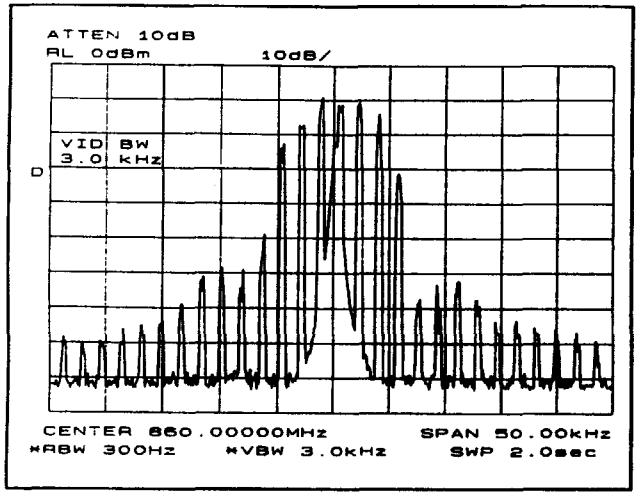


e) 10 Sweep Max Hold, Peak Detection,
100 Hz Resolution Bandwidth

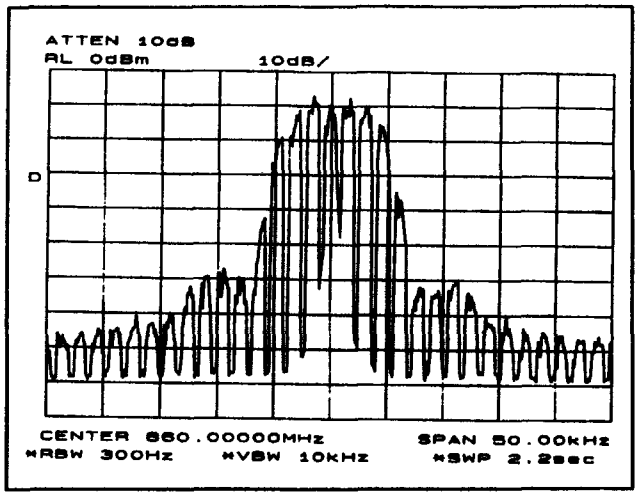


f) True RMS Average Detection,
100 Hz Resolution Bandwidth

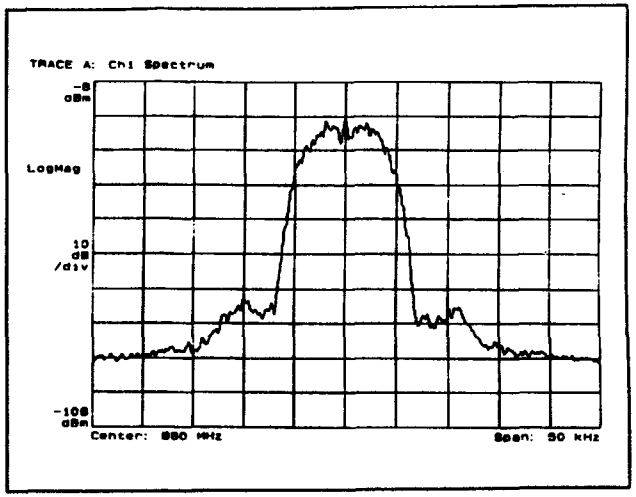
Figure 6 - Effects of Measurement Methods on TDMA QPSK Modulation



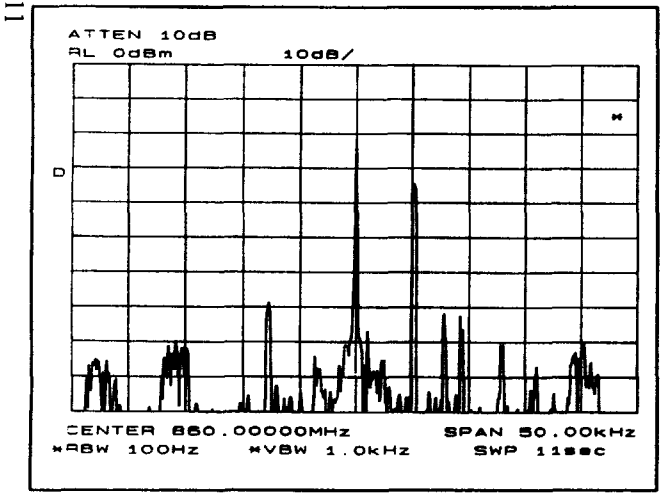
a) Single Sweep, Peak Detection,
300 Hz Resolution Bandwidth



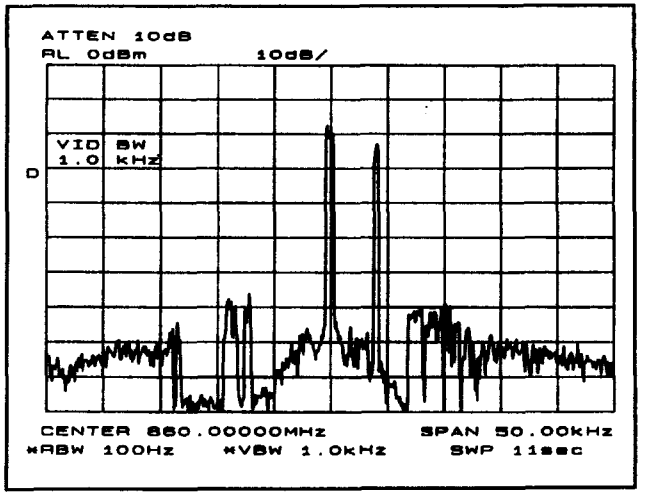
b) 10 Sweep Max Hold, Peak Detection,
300 Hz Resolution Bandwidth



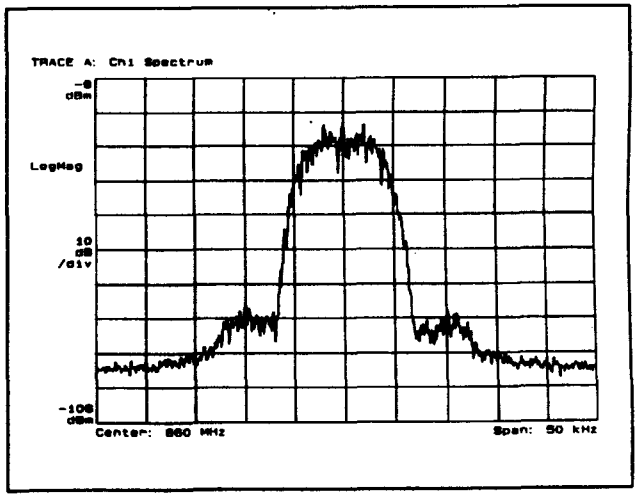
c) True RMS Average Detection,
300 Hz Resolution Bandwidth



d) Single, Sweep, Peak Detection,
100 Hz Resolution Bandwidth



e) 10 Sweep Max Hold, Peak Detection,
100 Hz Resolution Bandwidth



f) True RMS Average Detection,
100 Hz Resolution Bandwidth